Abstract

Active easterly waves are clearly observed by satellites over the western Africa and tropical Atlantic Ocean in the summertime. Tropical depressions and tropical storms are frequently seen as a result of wave breaking and cyclogenesis. Under the prevailing easterlies, dust outbreaks from the Sahara Desert appear to coincide with storm development along the western and southern boundaries of Saharan air layer (SAL). An integrated month-long field experiment, NAMMA (NASA African Monsoon Multidisciplinary Analysis), was thus conducted from August 15 to September 15, 2006 using a suite of remote sensing and in-situ sensors onboard DC-8 and B-200 airplanes together with ground networks and EOS A-train satellites to derive dust and cloud properties. In this paper, case studies of dust outbreaks coincident with DC-8 flights and satellite measurements are focused. Simulated cloud hydrometeors and surface precipitation will be presented, along with available in situ and TRMM (Tropical Rainfall Measuring Mission) counterparts, during the conference presentation.

In-situ and Satellite Measurements

The DC-8 airborne in-situ observations of dust size distribution, scattering/absorption profiles, and associated meteorological parameters [Chen et al., 2007] provide unique measurements at limited locations while satellite observations cover a large space routinely. The use of in-situ data to validate satellite retrievals and subsequently using satellite data to evaluate spatial variabilities of dust parameters over the model domain is essential for the comparison with model assimilation. In this study, the uniquely derived dust heights from MODIS (Moderate Resolution Imaging Radiometer) and AIRS are compared with in-situ dust profiles to characterize dust vertical extent of SAL (Saharan Air Layer) in addition to dust loading and effective radius (size) obtained from MODIS standard aerosol products. Shown in Figure 1 are the linear regressions of AIRS- and MODIS-derived aerosol optical depth (AOD) assuming dust layers at 700-800 and 800-900 mb, respectively. The corresponding correlation to the linear regression indirectly indicates the likelihood of the position of dust layer [DeSouda-Machado et al., 2006]. To achieve the best estimate of dust layer height, we restrict the correlation coefficient to be greater than 0.8 [Chu et al., 2007].

An optimal estimation method is undergone testing for retrieving both dust and temperature from AIRS as opposed to the use of ECMWF temperature profile as background in the retrievals shown in Figure 1.
1. Detailed results will be illustrated in the conference presentation.

**GEOS-5 Assimilated Meteorological Fields**

NASA GEOS-5 (Goddard Earth Observing System Model, Version 5) products assimilated meteorological fields provide large-scale forcing to the cloud-resolving model. During NAMMA, three tropical storms were developed into hurricanes while dust outbreaks were frequently seen throughout the NAMMA field campaign. The GEOS-5 6-hourly meteorological and large-scale temperature and moisture forcing data were averaged over a selected box region between 100W-320W and 8°N-20°N. The reason we selected the region because several legs of DC-8 flights were conducted during NAMMA field campaign.

**GCE (Goddard Cloud Ensemble) Model Bulk Scheme Simulations**

The period of “point-source” (the box-area averaged) GEOS-5 data from August 18 to 31, 2006 has then been applied to perform the cloud simulations for a horizontal domain of 512x512 km (with a resolution of 2x2 km) and a height of about 20 km (with 34 vertical levels of resolutions ranging from 80 m to 1000 m). The series of 14-day simulations mainly include 12 atmospheric 3D parameters (temperature, water vapor, horizontal and vertical velocity, pressure, long-wave and short-wave radiation rates, and five different cloud species, cloud water, rain, cloud ice, snow and graupel), along with the upward/downward short-wave and long-wave radiation fluxes at both top and bottom boundaries, which are generated at a 12-second time step, and saved with an hourly sample rate. Shown in Figure 2 are the results of cloud water, rainwater, cloud ice, snow, and graupel simulated by the 2-D GCE bulk scheme.
Concluding Remarks

Though the magnitudes of the hydrometeors vary slightly from day to day, cloud water and rainwater are largely concentrated below 600 mb whereas cloud ice, snow, and graupel are generally above 700 mb. Figure 3 demonstrates the time-averaged vertical profiles of the hydrometeors over the 14-day period. The results clearly show a physically consistent scenario that convections are prevail under a cold/moist environment, yet are suppressed under a warm/dry condition.

Numerical simulations using a WRF model with a two-moment scheme will soon conducted for investigating the dust impact on the targeted convective systems, for which satellite-derived dust height will be used to the impact of spatial variability on the model simulations.

References

Chen Gao, K. L. Thomhill, C. Kittaka, K. Gleicher, E. Winstead, G. Diskin, Bruce Anderson et al., The microphysical and optical properties of Saharan dust as observed during NAMMA. AAAR, Austin, Texas, September 2007.
